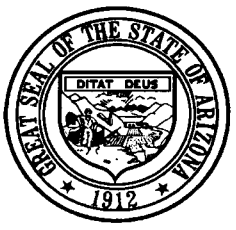
CHAPTER

3

Water Use Characteristics



3.1 INTRODUCTION

As discussed in Chapter 2, the Phoenix Active Management Area (AMA) has a combination of groundwater and surface water supplies available which have been an asset to the water management of the area. However, limitations exist which restrict accessibility to renewable supplies. Institutional constraints, physical distribution, and reliability can limit a supply over an area as large as the Phoenix AMA. Surface water projects have been developed throughout Arizona's history and are protected by a series of water rights. The use of the majority of Salt and Verde River water is limited to those lands that have obtained the right to use this supply, and cannot be removed, used, or sold separately from those lands. Also, many water users are located in areas that do not have direct access to renewable supplies either due to large distances from distribution systems or the lack of financial capability to construct physical transmission and distribution systems. Renewable supply reliability is almost exclusively dependent on weather patterns in the watershed which can limit the amount and timing of available supplies. Other factors can also limit the use of a supply such as water quality constraints, public perceptions, and demand requirements. The Department of Water Resources (Department) has developed many water management alternatives that have been effective in mitigating some of these constraints. These alternatives will be discussed in detail in subsequent chapters.

Although there are significant limitations in the distribution of renewable supplies, water users in the Phoenix AMA have been successful in increasing the utilization of these supplies while decreasing dependency on groundwater. The switch to renewable supplies has decreased the overdraft in the Phoenix AMA since the management plans went into effect. Additional renewable supply utilization combined with comprehensive conservation programs are the water management objectives that the Department will use to move the AMA closer to its goal of safe-yield. However, in order to develop an effective water management program designed to achieve the management goal of the region, the water use characteristics of the end users must first be evaluated.

This chapter describes historic and current water use patterns in the Phoenix AMA within three water demand sectors: agricultural, municipal, and industrial. Sources of water supply that have been used over time and trends in their use are discussed, as well as expected supply source utilization in the future. Finally, a water budget of current demand and supply conditions within each sector is presented, which illustrates the need for continued conservation and augmentation efforts during the third management period to realize progress toward achieving the AMA goal of safe-yield by 2025.

Each water demand sector has unique water use characteristics which affect the AMA's ability to achieve safe-yield. Agricultural use includes water used for irrigation of crops for animal or human consumption by all farming operations within the AMA who are required to report their water use to the Department (all irrigation grandfathered rights of two or more acres). Municipal uses include water supplied by cities, towns, private water companies, and irrigation districts for non-irrigation uses (including domestic, industrial, and commercial purposes). Industrial use includes groundwater withdrawn pursuant to a non-irrigation grandfathered groundwater right (Type 1 and Type 2 non-irrigation) or withdrawal permits for industrial purposes, such as irrigation of school grounds, parks, or golf courses, and for sand and gravel operations, dairy and feedlot operations, and electrical power generation.

In addition to these demand sectors, three Indian communities are located within the boundaries of the Phoenix AMA: the Salt River Pima-Maricopa Indian Community, the Fort McDowell Indian Community, and the northern portion of the Gila River Indian Community (also extending into the Pinal AMA). The water use by these communities is exempt from regulation by the state. However, it is important to include these uses in an assessment of water use for the AMA as the demand characteristics of these communities have a hydrologic impact on the safe-yield goal. These communities are dominated by agricultural uses, with a small portion of domestic uses and some commercial and industrial uses such as shopping centers and gaming facilities. It is expected that agricultural uses within the Indian communities may increase due

to the urbanization outside of these areas, relocation of farms from non-Indian agricultural areas, and increased commercial opportunities within the communities. Historical Indian water use has been collected and divided into agricultural and municipal uses. This information is incorporated into the discussions for each water demand sector.

Table 3-1 illustrates water demand within each demand sector within the Phoenix AMA for the years 1985, 1990, and 1995. As shown in the table, in 1995 agricultural use comprised 58 percent of the total use in the AMA, municipal use accounted for 38 percent of the reported water use, the industrial sector accounted for 4 percent of the total water use. A comparison of the 1985 and 1995 Phoenix AMA total demand results in an approximate decrease of 4 percent. However, as will be discussed in the subsequent sections of this chapter, demand characteristics in the Phoenix AMA are affected by a number of factors, each having a unique impact within each of the demand sectors. For instance, the table shows that the agricultural sector still accounts for the majority of the total water use in the AMA. However, as a proportion of total water use, agricultural use has declined with the municipal proportion subsequently increasing. Factors such as urbanization of agricultural lands may be one reason for this decline. As described later, other factors such as a depreciation in the farm economy or the impact of federal assistance programs may temporarily result in a reduced agricultural demand.

TABLE 3-1
1985, 1990, AND 1995
WATER DEMAND BY SECTOR
PHOENIX ACTIVE MANAGEMENT AREA

	1985		1990		1995	
Sector	**Total Use (acre-feet)**	**% of AMA**	**Total Use (acre-feet)**	**% of AMA**	**Total Use (acre-feet)**	**% of AMA**
Agricultural [1]	1,622,039	69	1,260,186	60	1,333,885	58
Municipal [2]	657,191	28	782,474	37	869,962	38
Industrial	73,485	3	73,767	3	83,088	4
TOTAL	**2,352,715**		**2,116,427**		**2,286,935**	

[1] Includes Indian Agriculture use
[2] Includes Indian Municipal & Industrial use, deliveries to Palo Verde Nuclear Generating Facility, and exempt wells

Water users within the Phoenix AMA have historically utilized both surface water and groundwater supplies. Beginning with the post-World War II period, a cotton boom occurred and additional agricultural lands were brought into production. Additionally, people and industry moved to the area and a period of rapid growth occurred. These factors resulted in steadily increasing demands on the groundwater supply and have led to the need for augmentation of renewable supplies and groundwater use limitations. After the Groundwater Code (Code) went into effect in 1980, supply composition began to slowly change. Although approved by Congress in 1968, water from the Central Arizona Project (CAP) first became available to the Phoenix AMA in 1985. The use of this supply has increased annually, especially with the flexibility provided by artificial recharge to store excess CAP water. Prior to this, surface water from the Salt and Verde Rivers was the largest source of renewable supplies to this region. With the aid of the Salt River Project (SRP), its series of reservoirs and large distribution system, water from the Salt and Verde Rivers is heavily utilized in all water demand sectors. Additionally, although the reuse of effluent is not a new concept to this area, widespread utilization has historically been limited by institutional constraints, the location of wastewater treatment facilities, and public perceptions. Technological and institutional progress is continuously being made in the area of effluent reuse, either through direct use or artificial

recharge and recovery facilities. Effluent reuse is becoming an increasingly larger proportion of the water use in the Phoenix AMA.

As stated earlier, the utilization of renewable water supplies has increased in the Phoenix AMA. This is especially true of the municipal sector. Even as water use increases in this sector, due to population increases, many municipal providers have taken advantage of the availability of renewable supplies and thus have become less reliant upon groundwater sources throughout the first and second management periods. Total water use in the agricultural sector has also declined from historic levels, however, this may be misleading since the utilization rate of agricultural lands is relatively low. If the agricultural land utilization rate increases, the minor declines in use over this period may vanish. As urbanization continues in agricultural areas that currently receive renewable supplies, the remaining agricultural demand will be dependent upon groundwater supplies unless access to renewable supplies is extended. Though only a small proportion of the total AMA water use, industrial use has increased approximately 13 percent from 1985 to 1995, with less than 1 percent of the increase being supplied by non-groundwater supplies. Table 3-2 illustrates total groundwater, effluent, and surface water use by each water demand sector for the years 1985, 1990, and 1995.

While a decline in total water use of 3 percent has occurred between 1985 and 1995, groundwater use has decreased approximately 19 percent in that same period. Many factors have contributed to the water demand and supply changes in this period. The following sections describe more fully water use in each of the demand sectors: agricultural, municipal, and industrial. Indian water use has been incorporated into the agricultural and municipal demand information, as appropriate.

TABLE 3-2
1985, 1990, AND 1995
WATER USE BY SOURCE (ACRE-FEET)
PHOENIX ACTIVE MANAGEMENT AREA

Year	Agricultural	Municipal	Industrial	Total Use
1985 TOTAL	**1,622,039**	**657,191**	**73,485**	**2,352,715**
Groundwater	772,632	276,541	62,558	1,111,731
Effluent	32,325	10,654	571	43,550
CAP	0	0	0	0
Surface Water	817,082	369,996	10,356	1,197,434
1990 TOTAL	**1,260,186**	**782,474**	**73,767**	**2,116,427**
Groundwater	816,047	292,047	67,649	1,175,743
Effluent	35,554	52,514	4,014	92,082
CAP	72,480	150,827	395	223,702
Surface Water	365,433	287,086	1,709	624,900
1995 TOTAL	**1,333,885**	**869,962**	**83,088**	**2,286,935**
Groundwater	573,183	253,585	71,285	898,053
Effluent	36,353	70,355	3,023	109,731
CAP	121,238	151,791	1,530	274,559
Surface Water	603,111	394,231	7,250	1,004,592

3.2 AGRICULTURAL WATER USE CHARACTERISTICS

Agricultural water use includes water supplied for irrigation of crops grown for human or animal consumption. Water users within this sector use a combination of surface water, effluent, and groundwater to meet annual demands. The availability of non-groundwater supplies is primarily dependent upon the location of the farm within an irrigation district that has existing surface water rights and a system capable of distributing the supply.

3.2.1 Agricultural Demand

The Department regulates all Irrigation Grandfathered Rights (IGFRs) within AMAs. Indian agriculture is not regulated. In 1994, IGFRs that were 10 acres or less, and not part of an integrated farming operation, were deregulated as a result of the Small Water Rights Bill. Laws 1986, Ch 107, §§ 2 and 3. Pursuant to this Bill, IGFRs in this "small farm" category were no longer required to report annual water use and comply with water duty limitations. Historically, these small farms made up about half of the IGFRs in the Phoenix AMA, but only accounted for 4 percent of the total use. Historic water demand figures described in this discussion include the small exempted rights.

Demand in the agricultural sector is influenced primarily by three factors: the number of acres irrigated, the crops grown, and the efficiency of water application. Agricultural users are assigned an irrigation efficiency requirement under the management plans (see Chapter 4, Agricultural Conservation Program). Additionally, pursuant to the Code, no new agricultural acres can be put into production, significantly limiting the potential for increases in agricultural demand in the future. Due to a combination of these factors and the urbanization of the Phoenix AMA, total water use in the agricultural sector has declined since the Code went into effect. Indian agricultural water use will be discussed separately from non-Indian agriculture due to the impact of water availability and regulations outside of the Indian communities. Table 3-3 shows annual historical agricultural water use from 1985 through 1995 and the sector's groundwater use characteristics.

In 1985 the agricultural sector used 1,622,039 acre-feet of water, comprising 69 percent of the total AMA water demand, and 70 percent (772,632 acre-feet) of the total groundwater used in the AMA. Water use in 1995 totaled 1,333,885 acre-feet, or 58 percent of the total AMA water use. Of the total 1995 water use in this sector, groundwater in the amount of 573,183 acre-feet was used in this sector which made up 64 percent of the total AMA groundwater use.

3.2.1.1 Non-Indian Agricultural Demand

Non-Indian agriculture accounts for approximately 83 percent of the total agricultural water use in the Phoenix AMA. Unlike Indian agriculture, it was expected that water use in this sector would decline as a result of urbanization. In 1985, the non-Indian agricultural sector used 1,363,530 acre-feet of water and 663,738 acre-feet of groundwater. Water use declined approximately 19 percent by 1995 when water use by non-Indian agriculture totaled 1,109,105 acre-feet. Of the total water use in 1995, groundwater in the amount of 482,151 acre-feet was used in this sector, which made up 43 percent of the non-Indian agricultural water use. A total of 3,575 IGFRs were being monitored in 1995 in the Phoenix AMA covering approximately 308,681 acres (not including exempt right holders who are not required to report annual water use). Most of these right holders are located within the boundaries of one of 20 irrigation districts located in the Phoenix AMA, with 80 percent of the total use located in the seven largest irrigation districts: SRP, Roosevelt Irrigation District, Roosevelt Water Conservation District, Buckeye Water Conservation and Drainage District, New Magma Irrigation and Drainage District, Maricopa Water District, and Queen Creek Irrigation District.

TABLE 3-3
1985-1995
AGRICULTURAL WATER DEMAND
PHOENIX ACTIVE MANAGEMENT AREA

Year	Non-Indian Demand [1] (acre-feet)	Indian Demand (acre-feet)	Total Demand (acre-feet)	Total Groundwater Demand (acre-feet)	Groundwater % of Total Agricultural Demand
1985	1,363,530	258,509	1,622,039	772,632	48
1986	1,003,036	258,509	1,261,545	734,453	58
1987	1,246,076	258,509	1,504,585	642,702	43
1988	1,222,109	252,790	1,474,899	664,111	45
1989	1,217,557	251,365	1,468,922	758,513	52
1990	1,023,970	236,216	1,260,186	816,047	65
1991	974,652	234,803	1,204,455	596,784	49
1992	909,098	223,822	1,132,920	513,560	45
1993	962,066	221,651	1,183,717	563,810	48
1994	1,067,352	223,467	1,290,819	627,630	49
1995	1,109,105	224,780	1,333,885	573,183	43

[1] Includes small exempt water use

When comparing demand in the non-Indian agricultural sector between 1985 and 1995, water use has declined. However, in recent years, due possibly to a combination of dry weather conditions and a recovery in the agricultural economy, an increase in water demand has been exhibited in this sector. Overall, water use in the agricultural sector has fluctuated throughout the period. Additional factors that can affect demand in this sector are discussed below.

3.2.1.1.1 Crop Water Requirements

The consumptive use of a particular crop will impact the water use on a farm. Although the conservation requirements developed for agricultural water users are based on the crops grown between 1975 and 1979, producers are given the flexibility to grow any crop as long as they can achieve their conservation requirements. Because of the relatively moderate climatic conditions in the Phoenix AMA, producers also have the flexibility to double-crop their acreage with summer and winter crop varieties. To maximize land productivity, rotation of several crops over a period of years is also practiced.

The crops predominantly grown in the Phoenix AMA include cotton, alfalfa, wheat, and barley. Other crops grown throughout the area include vegetables, citrus, potatoes, and melons. Although the total number of cropped acres has declined, there has not been a significant change in the historic crop mixes within the Phoenix AMA since 1980. Consumptive use values for the crops grown in the Phoenix AMA are listed in Appendix 4. Table 3-4 shows the percent of the top four crops grown in proportion to the total crops grown in the Phoenix AMA from 1975 through 1979 compared to the period 1992 through 1996.

Cotton remains the principal crop grown in the Phoenix AMA, accounting for almost half of the total crop production. On average, no significant change in the principal crops can be seen between these two periods. Wheat production in the period 1992 through 1996 has begun to increase but cotton and alfalfa production, with a consumptive use of 3.43 acre-feet per acre and 4.69 acre-feet per acre respectively, remain the largest proportion of crops in the Phoenix AMA.

TABLE 3-4
PROPORTION OF TOTAL CROPS GROWN (%)
COMPARISON: 1975-1979 TO 1992-1996
PHOENIX ACTIVE MANAGEMENT AREA

	1975	1976	1977	1978	1979	Average
Cotton	25.1	31.9	46.6	50.8	58.2	42.5
Alfalfa	20.5	19.1	17.8	18.2	13.2	17.8
Wheat	19.2	25.5	9.0	8.8	7.8	14.1
Barley	10.8	5.8	5.2	3.0	3.7	5.7
TOTAL	75.6	82.3	78.6	80.7	82.9	80.0
	1992	**1993**	**1994**	**1995**	**1996**	**Average**
Cotton	55.3	49.9	47.0	49.3	40.2	48.3
Alfalfa	16.7	16.3	18.3	18.5	18.3	17.6
Wheat	7.2	10.6	12.7	11.3	16.8	11.7
Barley	3.1	5.0	4.7	3.1	6.2	4.4
TOTAL	82.3	81.8	82.7	82.2	81.5	82.0

NOTES:
1. From the Arizona Agricultural Statistics, various years.
2. The tables exclude acreage outside of Maricopa County that is within the Phoenix AMA (such as NMIDD) and include acreage outside of the AMA but inside Maricopa County (such as the Gila Bend and Harquahala Valley areas).
3. Cotton combines Upland and American Pima.
4. Wheat combines Winter and Durum.
5. Data from 1996 are preliminary.

3.2.1.1.2 Cropping Patterns

Cropping patterns (i.e., crop mixes, acres in production, and crop rotations) have a significant impact on water demand in this sector. It was expected that urbanization of agricultural lands within the Phoenix AMA would lead to a proportionate decline in cropped acres throughout the management periods. Urbanization has occurred in the Phoenix AMA at phenomenal rates. However, not all urbanization has occurred on agricultural lands, and agricultural water use has fluctuated. An analysis of trends in agricultural demand is also complicated by the difficulty associated with obtaining information required by the Department, such as crops grown, acres in production, and other farming practices. It is not known for certain how many acres are in production on an annual basis. Lack of information on farming practices such as double-cropping, crop rotation, and land fallowing also make it difficult to assess annual water demand.

The decision to grow a particular crop and how much land to put into production in any year is based on a number of factors including economic conditions, water prices, weather, and local planting conditions. One of the leading factors that may have affected cropping patterns over the past 20 years has been federal commodity incentive programs, including acreage reduction programs (land fallowing). Government-set

target prices for wheat, feed grains, rice, and cotton exceed market prices. Therefore, acreage reduction programs were implemented to limit federal budget disbursements and to prevent the build up of surplus commodities held by the government. Participation in acreage reduction programs was voluntary, however, producers had to participate to be eligible for program benefits, such as price and income supports, crop insurance, farm loans, and deficiency payments. Through the 1996 Farm Bill, acreage reduction restrictions were lifted, allowing participating producers to plant 100 percent of their total contract acreage, plus any additional acreage, with any crop (with limitations on fruits and vegetables) with no loss in benefits.

Although it was expected that urbanization of agricultural lands in the Phoenix AMA would lead to a decline in cropped acres, the change in the incentives for acreage reductions and any boost in agricultural economic conditions may increase the land utilization rate. Since 1984 when the Phoenix AMA certified approximately 389,000 irrigation acres, approximately 60,000 acres have gone out of production due to conversion of those acres to non-irrigation uses, a reduction of approximately 17 percent. Alternatively, some acres available for production have not been cultivated continuously due to unfavorable economic conditions or programs that provide incentives for fallowing (acreage reduction). The Department estimates that approximately 161,797 acres were cropped in 1995, out of a potential 326,695 acres (including exempt and non-exempt rights). This represents a 49 percent land utilization rate. Between 1984 and 1995, a 17 percent decline in potential cropped acreage was experienced and total water use declined approximately 13 percent. However, comparing annual acreage reduction and water use between 1984 and 1995 has not shown any consistent trend. Table 3-5 shows that irrigation acres within the Phoenix AMA have been consistently declining. However, total agricultural water use has been inconsistent with the acreage reductions, fluctuating throughout the period.

3.2.1.1.3 Application Rates

Application rates for the AMA or for individual areas could provide information important to the agricultural conservation program. The application rate can be determined by comparing the amount of water applied each year to the acreage actually in production. This analysis would make it possible to determine the demand for specific crops for different years. However, the Department does not require producers to report the number of acres in production in each year. Based on the information in section 3.2.1.1.2, comparing water use and irrigation acres (see Table 3-5), overall agricultural water use has not been consistent. Increases in total water use of up to 24 percent have been exhibited as well as a decrease of 26 percent. These fluctuations in total water use could be a result of extreme weather conditions, such as higher consumptive use and evaporation in warmer/drier years, changes in agricultural economic conditions, or changes in water conservation practices. Nonetheless, water use trends do not exhibit the same trends as irrigable acreage (which may or may not bear any correlation to cropped acreage). Additional data regarding application rates could assist the Department in its AMA-wide water use analyses.

3.2.1.2 Indian Agricultural Demand

Annual water use by Indian communities is not required to be reported to the Department. Thus, for the purposes of this chapter, agricultural water use on Indian lands is estimated using information obtained from SRP annual water reports and water right settlement information. Irrigable farmland for all three Indian communities in the Phoenix AMA in 1986 was estimated to be 59,271 acres, with 29,423 acres actually in production (50 percent land utilization). In 1995, the farmland in production was estimated to be 36,925 acres, an increase in land utilization of approximately 12 percent from 1986. Agricultural water use in 1987 was estimated at 258,509 acre-feet (108,894 acre-feet of groundwater and 149,615 acre-feet of surface water). Water use decreased to 224,780 acre-feet in 1995. Because water users in these areas are not subject to the conservation requirements or acreage restrictions, it is projected that agricultural water use will increase in the future. Projections for future Indian agriculture are discussed in more detail in

Chapter 11 of this plan. Table 3-6 shows the estimated water use for 1990 through 1995 for Indian agriculture located in the Phoenix AMA.

TABLE 3-5
1984-1995
NON-INDIAN AGRICULTURE
COMPARISON: TOTAL WATER USE/IRRIGATION ACREAGE
PHOENIX ACTIVE MANAGEMENT AREA

Year	Total Water Use (acre-feet)	Certified Irrigation Acres	Annual % Change in Water Use	Annual % Change in Acreage
1984	1,244,466	389,000		
1985	1,363,530	365,501	+ 10	- 6.0
1986	1,003,036	355,467	- 26	- 2.7
1987	1,246,076	347,297	+ 24	- 2.3
1988	1,222,109	343,826	- 2	- 0.9
1989	1,217,557	339,368	- 1	- 1.0
1990	1,023,970	338,588	- 16	- 0.2
1991	974,652	336,804	- 5	- 0.5
1992	909,098	334,709	- 7	- 0.6
1993	962,066	331,454	+ 6	- 0.9
1994	1,067,352	328,788	+ 11	- 0.8
1995	1,109,105	326,695	3	- 0.6

TABLE 3-6
1990-1995
INDIAN AGRICULTURAL DEMAND
PHOENIX ACTIVE MANAGEMENT AREA

Year	Total Demand (acre-feet)	Groundwater % of Total Use
1990	236,216	67
1991	234,803	47
1992	223,822	48
1993	221,651	44
1994	223,467	37
1995	224,780	41

3.2.2 Agricultural Supplies

Groundwater use accounted for approximately 43 percent of the total agricultural supplies utilized in 1995. This is a reduction from 1985 when groundwater accounted for about 48 percent of the agricultural supply. However, as shown previously in Table 3-3 (section 3.2.1), the utilization of groundwater in the agricultural sector has fluctuated between 1985 and 1995, ranging between a low of 43 percent of the total agricultural use in 1987 and 1995 and a high of 65 percent in 1990. The use of surface water in this sector is highly dependent upon the location of the IGFR within an irrigation district that has access to renewable supplies, weather conditions on the watershed, and the cost of the surface water compared to groundwater pumping. Table 3-7 shows the 1995 utilization of supplies by irrigation district, right holders outside of irrigation districts, and the Indian communities.

Agricultural water users outside of irrigation districts are almost entirely dependant upon groundwater sources to meet demand. The majority of the surface water use is located within a few irrigation districts: SRP, Roosevelt Water Conservation District, Buckeye Water Conservation and Drainage District, New Magma Irrigation and Drainage District, Maricopa Water District, and Queen Creek Irrigation District. Effluent is also utilized in the Phoenix AMA by agricultural water users. Effluent reuse has been facilitated through agreements for effluent discharge from the 91st Avenue Wastewater Treatment Plant (WWTP). The Buckeye Water Conservation and Drainage District has contracted with the Multi-City Sub-Regional Operating Group (participants in the 91st Avenue WWTP), made up of the cities of Phoenix, Mesa, Scottsdale, Tempe, and Glendale to receive 30,000 acre-feet of effluent per year. Through a water exchange agreement with the City of Phoenix, the Roosevelt Irrigation District is entitled to utilize up to 30,000 acre-feet of effluent per year, although Phoenix actually gets credited with the effluent use in their accounting (see Water Exchanges, A.R.S. § 45-1001, *et seq.*). Additionally, the Gila River Indian Community uses effluent generated at the Chandler Lone Butte WWTP.

Agricultural water users began utilizing CAP water when it became available in the Phoenix AMA in 1986. Many irrigation districts entered into subcontracts for CAP water with the Central Arizona Water Conservation District (CAWCD), the agency responsible for CAP repayments to the federal government. However, many agricultural water users were unable to pay the charges required under the CAP sub-contracts. Thus, in 1994, in exchange for waiving their rights to receive delivery of CAP water under long-term contracts, defaulting irrigation districts were entitled to receive excess CAP water (subject to the availability of the water in each year) on a short-term basis at low rates set by CAWCD. This price incentive CAP water is referred to as "Pool water." Pool 1 water was made available to each district that executed a CAP subcontract prior to October 1, 1993. Pool 2 water was made available to non-Indian irrigation subcontractors who relinquished all or a portion of the original entitlement between October 7, 1993 and January 1, 1994. A volume of approximately 98,000 acre-feet was made available through Pool 1 and Pool 2 to Phoenix AMA agricultural users.

In addition to the pricing incentive described above, some irrigation districts in the Phoenix AMA agreed to implement groundwater savings (in-lieu recharge) projects with municipal CAP subcontractors, CAWCD, and the Arizona Water Banking Authority (otherwise known as water storers) in exchange for CAP water at rates comparable to groundwater pumping. These agreements allowed the water storers to offer CAP water at a low cost to irrigation districts and irrigation right holders who then agreed to reduce their groundwater pumping in an equal proportion to the amount of CAP water used. As a result, the water storers received credits for the recovery of CAP water within their service areas for every acre-foot of groundwater that was not pumped. Although the legal characteristic of the in-lieu water used by the agricultural sector is considered groundwater (see Chapter 8 for a detailed description of groundwater savings facilities), this option has lead to significant "banking" of excess CAP water for use by municipalities or other users in times of need.

TABLE 3-7
1995 AGRICULTURAL WATER USE BY SOURCE (ACRE-FEET)
PHOENIX ACTIVE MANAGEMENT AREA

	Ground-water Pumped	In-Lieu Water [1]	CAP Water	Direct Use Effluent	Surface Water	Tailwater	Total Water Use
SRP	29,628	0	0	4,028	265,947	1,500	301,103
RID	150,226	0	0	0	4,635	2,630	157,491
RWCD	38,188	19,119	15,120	0	45,287	138	117,852
BWCDD	4,508	0	0	30,000	67,683	769	102,960
NMIDD	7,446	26,516	57,943	0	0	0	91,905
MWD	26,164	0	0	0	53,759	510	80,433
QCID	13,886	8,656	34,375	0	0	0	56,917
All Other Districts	29,485	2,177	13,800	0	26,576	792	72,830
Outside Districts	126,152	0	0	0	0	1,462	127,614
Indian Communities	91,032	0	0	2,325	131,423	0	224,780
TOTAL	**516,715**	**56,468**	**121,238**	**36,353**	**595,310**	**7,801**	**1,333,885**

Salt River Project (SRP), Roosevelt Irrigation District (RID), Roosevelt Water Conservation District (RWCD), Buckeye Water Conservation and Drainage District (BWCDD), New Magma Irrigation and Drainage District (NMIDD), Maricopa Water District (MWD), and Queen Creek Irrigation District (QCID).

[1] Counted as groundwater in water use accounting.

Table 3-8 shows the historic use of in-lieu CAP water in the agricultural sector, since the program began in 1992, and CAP water directly used in the agricultural sector between 1990 and 1995. It is important to note that the in-lieu water is accounted for as groundwater pursuant to the groundwater savings facility requirements and thus is not reflected as CAP or surface water use in the agricultural sector except in this table. Because of the incentive pricing and the in-lieu recharge program, CAP use by the agricultural sector has increased significantly from 1991 through 1995, as shown in Table 3-8.

3.2.3 Summary

The agricultural sector still accounts for the majority of the total water use in the Phoenix AMA and the largest use of groundwater. However, due to rapid urbanization and the Code prohibition on new agricultural acreage, the agricultural sector in the Phoenix AMA is expected to be surpassed by the municipal sector during the third or fourth management periods as the largest water demand sector. However, decreased reliance on groundwater is not expected in the agricultural sector, since the majority of acres to be urbanized will be from within irrigation districts that use primarily renewable water sources. The impact of the 1996 Farm Bill could increase the acreage put into production on an annual basis. However, urbanization will reduce the acreage available for irrigation. Additionally, it is expected that as

some of the lands outside of the Indian communities urbanize, farming will increase on Indian lands. Thus, agricultural acreage may decline, but not to the levels originally anticipated. It is assumed that the principal crops grown in the Phoenix AMA, for the most part, will remain the same. Most of the acreage that is anticipated to be urbanized is located within irrigation districts that have access to renewable supplies: SRP, Roosevelt Water Conservation District, and Maricopa Water District. Irrigation districts relying wholly or primarily on groundwater and IGFRs located outside of districts are not anticipated to urbanize at the same rates. Thus, the agricultural sector may become more dependent on groundwater in the future even though total water demand will decrease. Without any requirements to switch to renewable supplies, the agricultural sector will be contributing little to achievement of the Phoenix AMA management goal.

TABLE 3-8
1990-1995
NON-INDIAN AGRICULTURAL CAP WATER USE
PHOENIX ACTIVE MANAGEMENT AREA

	1990	1991	1992	1993	1994	1995
In-Lieu CAP Water (acre-feet)	0	0	81,560	125,710	10,917	56,468
Direct Use CAP Water (acre-feet)	39,569	26,967	10,102	5,480	142,124	121,238
% of Total Non-Indian Agricultural Use	4	3	10	14	14	17

3.3 MUNICIPAL WATER USE CHARACTERISTICS

Municipal water providers (cities, towns, private water companies, or irrigation districts) deliver water pursuant to service area rights administered under the Code. Municipal water use includes water delivered to residential customers for indoor and outdoor watering; water delivered to non-residential users such as industrial facilities, commercial properties, construction users, and individual users. Individual users include turf-related facilities, landscaped public rights-of-way, and new large cooling users served by a municipal system having been identified as having high water use rates, significant conservation potential, or high visibility within the service area. Municipal water use also includes untreated water delivered to residential customers for urban flood irrigation. Depending on supply availability, proximity to renewable supplies, and the ability to finance infrastructure, municipal water users are delivered a combination of groundwater, surface water, and effluent.

3.3.1 Municipal Demand

Water demand in the municipal sector is closely tied to population growth, and thus, has increased steadily as growth has occurred in the Phoenix AMA. Municipal providers are required to meet certain efficiency requirements for water use within their service areas, which are described in detail in Chapter 5 of this plan. Water use in the municipal sector is expected to continue to increase as population growth continues through the third management period. However, in addition to water use efficiency requirements, municipal demand in new residential development is required to be met with renewable supplies, under the Assured Water Supply Rules (also described in Chapter 5). Thus, the use of groundwater in this sector is not expected to increase.

Table 3-9 shows municipal water demand for each year from 1985 through 1995 in the Phoenix AMA and the percent of groundwater that supplies this demand. Spillwater and effluent, which are not calculated in

the gallons per capita per day compliance determination for municipal providers, are included in the total water use figure in order to illustrate actual water use patterns in the municipal sector. Water use in the municipal sector has increased in relative proportion to population growth. However, as shown below, although overall water use has increased, the proportion of groundwater use has declined from 1985 to 1995, as a result of increased utilization of renewable supplies.

TABLE 3-9
1985-1995
MUNICIPAL WATER DEMAND
PHOENIX ACTIVE MANAGEMENT AREA

Year	Non-Indian Municipal Demand [1] (acre-feet)	Indian Municipal Demand (acre-feet)	Total Municipal Demand (acre-feet)	Total Groundwater Use (acre-feet)	Groundwater % of Total Municipal Demand
1985	654,000	3,191	657,191	276,541	42
1986	699,285	3,191	702,476	304,207	43
1987	746,283	3,191	749,474	281,092	38
1988	785,506	3,587	789,093	253,386	32
1989	781,409	4,042	785,451	250,704	32
1990	778,090	4,384	782,474	292,047	37
1991	750,956	4,727	755,683	232,224	31
1992	761,699	5,125	766,824	197,871	26
1993	786,000	5,476	791,476	226,840	29
1994	823,473	7,131	830,604	271,351	33
1995	862,987	6,975	869,962	253,585	29

[1] Includes exempt wells and water demand at Palo Verde Nuclear Generating Facility

In 1985, municipal water use accounted for 28 percent of the total water use in the Phoenix AMA. By 1995, the municipal sector accounted for 37 percent of the total AMA water use. As stated previously, population growth has a significant impact on municipal demand, thus, as this growth has continued, total water use in this sector has also increased, although not proportionately. Total water use has not increased at the same rate as growth, suggesting that water use by new residential customers may be more efficient. Table 3-10 shows the total water use, population, and gallons per capita per day (GPCD) use rate for non-Indian municipal water providers for the years 1985, 1990, and 1995. As shown in the table, total per capita use for non-Indian municipal providers has declined since 1985.

3.3.1.1 Non-Indian Municipal Demand

Non-Indian municipal water use accounts for 99 percent of the total municipal use in the Phoenix AMA. In 1985, non-Indian municipal water use totaled 654,000 acre-feet. By 1995, water use increased approximately 32 percent, totaling 862,987 acre-feet (including water delivered to the Palo Verde Nuclear Generating Facility and water pumped from exempt wells).

TABLE 3-10
1985, 1990, AND 1995
NON-INDIAN MUNICIPAL GALLONS PER CAPITA PER DAY TRENDS [1]
PHOENIX ACTIVE MANAGEMENT AREA

	1985	1990	1995
Large Municipal Providers			
Total Use	492,748	570,403	656,146
Population	1,808,409	2,089,025	2,494,041
GPCD	243	244	235
Small Municipal Providers			
Total Use	9,007	13,775	9,868
Population	21,674	39,621	39,441
GPCD	371	310	223
Large Untreated Water Providers			
Total Use	128,889	132,756	135,218
Total Non-Indian Municipal Use			
Total Use	630,644	716,934	801,232
Population	1,830,083	2,128,646	2,533,482
GPCD	308	301	282

[1] Table does not include effluent deliveries to Palo Verde Nuclear Generating Facility or groundwater pumped from small exempt wells

In the Phoenix AMA, a total of 147 water providers are regulated under the Municipal Conservation Program. There are three primary categories of water providers in the municipal sector: large municipal providers, large untreated water providers, and small municipal providers. Thirty-two large municipal water providers supply the majority of potable water for use within the Phoenix AMA. In 1995, these 32 large providers supplied 656,146 acre-feet of water or 75 percent of the total municipal water demand. Large untreated providers supplied 135,218 acre-feet of untreated water for urban irrigation in 1995. Small municipal providers supplied 9,868 acre-feet in 1995. An additional 48,899 acre-feet of effluent is supplied to the Palo Verde Nuclear Generating Facility from the 91st Avenue WWTP and an estimated 12,856 acre-feet of groundwater is pumped by individual well owners not supplied by a water provider.

Table 3-11 compares water demand between the large municipal providers, large untreated providers, and the small municipal providers for the years 1985, 1990, and 1995 and their proportion of the total municipal demand supplied by a municipal provider. The following sections describe the water use patterns of each category of provider in the Phoenix AMA.

TABLE 3-11
1985, 1990, AND 1995
NON-INDIAN MUNICIPAL WATER DEMAND BY PROVIDER TYPE [1]
PHOENIX ACTIVE MANAGEMENT AREA

Year	Large Municipal Providers (acre-feet)	% of Total Municipal Use	Untreated Water Providers (acre-feet)	% of Total Municipal Use	Small Municipal Providers (acre-feet)	% of Total Municipal Use
1985	492,748	78	128,889	20	9,007	2
1990	570,403	80	132,756	19	13,775	1
1995	656,146	82	135,218	17	9,868	1

[1] Table does not include deliveries to Palo Verde Nuclear Generating Facility or groundwater withdrawn from exempt wells

3.3.1.1.1 Large Municipal Providers

Large municipal providers are water providers that serve more than 250 acre-feet of water annually and are regulated for compliance with specific conservation requirements, usually a total GPCD requirement, designed to achieve efficient water use within the service area (see Chapter 5). Large municipal providers account for the largest proportion of water use in the municipal sector. These providers include the largest cities and private utilities. In 1985 large municipal providers served approximately 98 percent of the AMA's population and provided 78 percent of the total water used for residential, industrial, construction, and commercial uses. By 1995, these large providers still accounted for 98 percent of the population but increased to 82 percent of the total water use in this sector. Large population increases, a limitation on the expansion of untreated water providers, as described in Chapter 5, and the acquisition of small provider service areas may be the cause of the increase in the proportion of large municipal provider water use.

Water use characteristics of large municipal providers are commonly analyzed by the Department based on the political subdivision (public or private ownership) of the provider. Due to the different abilities of each provider to adopt ordinances or finance water projects, dividing providers into municipalities and private water companies provides a better analysis of the characteristics of water use in this category. Other water providers in this sector include two military installations, one of which has been closed and is in the process of being sold. Municipalities include incorporated towns or cities who have the ability to set rates, pass ordinances, and finance bonds through public ballots or the governing body, usually through the town or city council. A private water company is an individually owned or corporately owned entity which distributes or sells water. Private water companies have no ability to pass ordinances and must obtain permission from the Arizona Corporation Commission (ACC) to incur debt. Additionally, the rates for water charged by the private water company are also regulated by the ACC. Table 3-12 is a comparison of water use characteristics of municipalities and private water companies in 1995.

In the Phoenix AMA, 13 municipalities (cities or towns) are regulated under the municipal program, 12 of which are large municipal providers. In 1995, municipalities accounted for 93 percent of the population and 91 percent of the water use by large municipal providers. Of the total water use by municipalities, 80 percent was supplied by surface water or other non-groundwater sources. Municipalities in the Phoenix AMA have access to multiple sources of water for distribution: groundwater, Salt and Verde River water from SRP and other diversions, treated and untreated CAP water, and effluent. The City of Phoenix with a 1995 water service area population of 1,149,486 is the largest municipal water provider in the Phoenix AMA. In 1995, the City of Phoenix comprised 45 percent of the AMA population and supplied 33 percent of the total municipal water supply (93 percent of the city's total use was from renewable supplies).

TABLE 3-12
1995 LARGE MUNICIPAL PROVIDERS
COMPARISON: MUNICIPALITIES AND PRIVATE WATER COMPANIES
PHOENIX ACTIVE MANAGEMENT AREA

	Population	% of Total Population	Total Use [1] (acre-feet)	Total Groundwater Use (acre-feet)	% of Total Municipal Use	GPCD Rate
Municipalities	2,332,199	93	599,671	121,653	91	230
Private Water Companies	161,842	7	56,475	50,316	9	312

[1] Does not include deliveries to Palo Verde Nuclear Generating Facility

Approximately 66 (20 large and 46 small) privately owned and operated water companies are regulated in the Phoenix AMA. They serve a wide range of development from relatively small, built-out communities to rapidly growing regions on the exterior boundaries of the metropolitan area. Development in these areas typically consists of either single family subdivisions or retirement communities associated with golf courses. Twenty of the 32 large municipal providers are private water companies. Private water companies regulated as large municipal providers supply approximately 7 percent of the population and account for 9 percent of the large provider municipal water use. The remaining "small" private water companies supply less than one percent of the total municipal water use in the Phoenix AMA. Most private water companies in the Phoenix AMA serve only groundwater, with the exception of Chaparral City Water Company in Fountain Hills, Cave Creek Water Company, Carefree Water Company, and Arizona Water Company - Apache Junction, who have developed the ability to directly serve renewable supplies. Other private utilities pump groundwater, but through water exchanges or other permits they can account for some of this water as non-groundwater supplies. In 1995, approximately 11 percent of the total water used by private water companies came from renewable supplies, a significant increase from 1985 when less than one percent of the total use consisted of renewable supplies.

3.3.1.1.2 Large Untreated Water Providers

Twenty-one large untreated water providers have been identified in the Phoenix AMA. These are providers who deliver untreated water (non-potable) to more than 500 persons or deliver 100 acre-feet or more of untreated water through a system separate and distinct from their potable system, or through an irrigation water distribution system. Sources of untreated water include groundwater, CAP water, and Salt and Verde River water and are commonly used for urban flood irrigation of residential pasture and turf landscaping. In 1985, water use in this category totaled 128,889 acre-feet, increasing to 135,218 acre-feet in 1995. Large untreated water providers are not regulated on a per capita basis but instead are assigned a rate of use requirement of 4 acre-feet per acre per year. Additionally, no new untreated water provider service areas can be established in the Phoenix AMA, however, expansion can occur within the current service areas of the untreated water provider. Future untreated water service outside the existing boundaries will be regulated in the same manner as the provider's potable water service area.

There are two general types of untreated providers in the Phoenix AMA: Municipal Untreated Water Providers (including private water companies, cooperatives, institutional facilities, and home owner associations) and Agricultural Untreated Water Providers (irrigation districts serving non-irrigation urban

uses). Large untreated water providers account for approximately 17 percent of the total municipal sector water use in the Phoenix AMA. The SRP is the largest provider in this category, accounting for approximately 85 percent of the total untreated deliveries. Appendix 5-B contains a complete list of the Phoenix AMA large untreated providers and their 1995 total water use. Untreated water deliveries have increased 5 percent since 1985. However, untreated water deliveries are not expected to increase at significant levels in the future, as most residential deliveries are expected to be met with potable supplies or are in areas that are not eligible to be designated as untreated water provider service areas.

3.3.1.1.3 Small Municipal Providers

Small municipal providers are defined as municipal providers that deliver 250 acre-feet of water or less for non-irrigation uses annually. Small providers are required to use water efficiently, but are not assigned volumetric conservation requirements. Currently, 82 active small municipal providers exist in the Phoenix AMA. Sixteen of those are former large municipal providers that were legislatively deregulated in 1994 under the Small Rights Bill (Sunrise Water Company and Desert Hills Water Company have since been transitioned back to large municipal providers as their use exceeded 250 acre-feet). Water use in this category has not changed significantly in the past 11 years and accounts for approximately one percent of the total municipal sector water demand. The average per capita use rate among small municipal providers is estimated to be 223 GPCD.

There are six general categories of small municipal providers: well cooperatives, mobile home parks, private water companies regulated by the Arizona Corporation Commission, institutional facilities, irrigation districts, and miscellaneous water providers. The most numerous of the small municipal providers are the 46 private water companies with a total water use of 4,365 acre-feet in 1995, or 45 percent of the total small provider water use. The remaining small providers include ten miscellaneous providers, nine mobile home parks, 12 well cooperatives in which several property owners share a well, one irrigation district, and four institutions.

3.3.2 Indian Municipal Demand

Municipal uses of water in the Indian communities include water used for domestic, commercial, and industrial facilities, gaming operations, and sand and gravel mining. Water use information other than agricultural uses were not historically collected for the Indian communities. Estimated water use information was based on estimated uses included in the Ft. McDowell Indian Community and Salt River Pima-Maricopa Indian Community water rights settlements and the Draft Gila River Indian Community Hydrologic Survey Report. Water supplied for this sector typically comes from pumped water which may not always be considered groundwater due to the proximity of wells to surface water systems and water rights settlement provisions. In 1987, municipal water use by Indian communities was estimated to be 3,191 acre-feet. By 1995, due primarily to the opening of gaming operations and limited commercial development, the water use increased to approximately 6,975 acre-feet. It is assumed that population estimates for the Indian communities have remained relatively stable over the past decade, however, this may change as opportunities for employment and other benefits increase with proposed economic development projects.

3.3.3 Municipal Supplies

Municipal providers in the Phoenix AMA originally developed groundwater supplies to provide a potable water source for residents and industries. Renewable supplies were developed for potable water distribution first by the largest cities to replace groundwater dependancy. In 1985, groundwater use in the municipal sector totaled 276,541 acre-feet, which accounted for 42 percent of the total municipal use. By 1995 groundwater use by municipal providers decreased to 253,585 acre-feet and was only 29 percent of

the total municipal water use. Table 3-13 shows the water sources used within the municipal sector for 1985, 1990 and 1995.

TABLE 3-13
1985, 1990, AND 1995
MUNICIPAL WATER USE BY SOURCE (ACRE-FEET)[1]
PHOENIX ACTIVE MANAGEMENT AREA

	Groundwater	CAP Water	Surface Water	Effluent	Palo Verde Effluent	Total Use
1985	276,541	0	369,998	154	10,500	657,191
1990	292,047	150,827	287,086	4,214	48,300	782,474
1995	253,585	151,791	394,231	21,456	48,899	869,962

[1] Includes Indian water use

The use of renewable supplies for municipal purposes first began in 1922 when the City of Phoenix built a pipeline from the Verde River and was able to provide the first non-groundwater potable supplies. In 1947, the Verde Water Treatment Plant was built to treat the city's entitlement to Verde River water. By 1952 the city began treating and serving its SRP entitlement. Since that time, many other large communities in the valley have begun to utilize their SRP surface water supplies.

Salt and Verde River water from SRP, with 331,215 acre-feet being directly used for municipal purposes in 1995, continues to be the primary surface water supply in the Phoenix AMA. Water from the SRP is the least expensive and in wet years the availability of free water, or spillwater, may increase the use of Salt and Verde River water. The construction of the CAP canal initiated the supply of Colorado River water to the Phoenix area in 1986. The cities of Phoenix, Chandler, Glendale, Scottsdale, Mesa, and Peoria, the Town of Gilbert, and Chaparral City Water Company have constructed water treatment plants or have plants under construction to treat CAP surface water supplies. Other providers such as the City of Chandler and Arizona Water Company - Apache Junction have agreements with the City of Mesa to treat CAP water for them. Other providers even use untreated CAP water for non-potable purposes such as golf course irrigation or storage underground for future use. Additionally, many Phoenix AMA cities have been actively pursuing the acquisition of CAP subcontracts from other providers that are not able to utilize this supply. Municipal subcontractors in the Phoenix AMA are entitled to 308,817 acre-feet of CAP water. In 1995, 151,791 acre-feet (49 percent) of the total Phoenix AMA municipal CAP entitlement was directly utilized by municipal providers. An additional 112,375 acre-feet was stored underground (not included in the demand figures because it is stored for future demand) for recharge credits, resulting in a total utilization of 85 percent of the Phoenix AMA municipal and industrial CAP allocation.

Effluent use has increased significantly since 1980. Most providers historically discharged their treated wastewater into streams, rivers, or disposal ponds. Improvements in treatment technologies, changing attitudes, and increasing costs associated with discharging into public waters (which requires water quality permits) have facilitated efforts to utilize effluent as a water supply. Although more than half of the available effluent is still being discharged, many municipal providers have contracted with end users to deliver treated effluent for direct use and/or have developed recharge facilities to store and recover effluent. For example, the Sub Regional Operating Group cities have contracted with Palo Verde Nuclear Generating Facility to deliver up to 140,000 acre-feet per year of effluent from the 91st Avenue WWTP for cooling reactors at the nuclear facility. Annual demand by Palo Verde has not exceeded 60,000 acre-feet to date, due in part to a reduced cooling capacity at the facility. Additional uses of effluent are being developed by many municipalities which will result in an increase in the use of this supply into the future.

Constraints on the utilization of renewable supplies include the location and lack of infrastructure relative to the CAP canal or other surface waterways. Regional solutions to these constraints are being explored by water providers in the Phoenix AMA. Other mechanisms of receiving renewable water supplies have been obtained through lease agreements with local Indian communities for CAP water, additional surface water supplies developed on the Salt and Verde Rivers through the increase of storage capacity at Roosevelt Dam, and the added flexibility of indirect use through recharge and recovery programs.

3.3.4 Summary

By the end of the third management period, municipal water use will surpass that of agriculture. Municipal water demand is closely tied to population increases. Although per capita water use fluctuates within a service area over time depending on a number of factors (see Chapter 5), added population almost always results in an increase in total water demand. The population in the Phoenix AMA has increased approximately 38 percent from approximately 1.8 million in 1985 to approximately 2.5 million in 1995 (including population within the three Indian communities). Eleven large providers have seen population increases of more than 50 percent in that same period. These population increases are occurring evenly in both municipalities and private water companies across the AMA. During the second management period, annual population increases for the AMA ranged between 2 and 7 percent per year.

The switch to renewable supplies by the largest water users in this sector has led to a reduction in groundwater use. Although CAP water replaced groundwater use for some of the larger providers, the availability of spillwater, which is not counted in compliance by the Department, had the largest impact on decreases in groundwater pumping in 1992, 1993, and 1995. Recharge and recovery of CAP, effluent, and SRP water has significantly increased the availability of renewable supply utilization in this sector. Finally, the Department's requirements for demonstrating an assured water supply will be essential in ensuring that the municipal sector will continue the development and utilization of renewable supplies.

3.4 INDUSTRIAL WATER USE CHARACTERISTICS

Industrial water users withdraw groundwater in accordance with non-irrigation grandfathered groundwater rights (Type 1 or Type 2 non-irrigation rights) or groundwater withdrawal permits. It is important to note that water supplied by municipal providers for industrial or commercial uses within their service areas is not included in this section as industrial water use; instead, it is identified and discussed in section 3.3 as non-residential municipal water use. Because of the definition of industrial users, this sector is primarily dependent upon groundwater, although a portion of the water use in this sector does come from surface water supplied by irrigation districts. Industrial users are also subject to annual conservation requirements, described in Chapter 6. The following industrial user groups have been assigned specific conservation requirements by the Department:

- Turf-Related Facilities
- Sand and Gravel Facilities
- Large-Scale Power Plants
- Large-Scale Cooling Facilities
- Dairy Operations
- Cattle Feedlot Operations
- New Large Landscape Users
- New Large Industrial Users
- Other Industrial Users

Industrial demand in the Phoenix AMA has increased since the Code went into effect. Because industrial uses are closely tied to population growth, it is anticipated that industrial demand will continue to increase.

3.4.1 Industrial Demand

As a proportion of overall AMA demand, industrial use has not increased significantly in the past ten years. In 1985 industrial use accounted for approximately 3 percent of the AMA use and has remained approximately 3 to 4 percent of the total AMA demand since that time. However, because industrial users are primarily dependent upon groundwater, the proportion of groundwater use in the industrial sector has increased as the municipal users have switched to renewable supplies. Table 3-14 illustrates industrial water demand for the years 1985, 1990, and 1995, in addition to the proportion of groundwater use in each year.

TABLE 3-14
1985, 1990, AND 1995
INDUSTRIAL WATER DEMAND
PHOENIX ACTIVE MANAGEMENT AREA

Year	Total Use (acre-feet)	Groundwater % of Total Industrial Use
1985	73,485	85
1990	73,767	91
1995	83,088	86

Total water use by industrial users has increased since 1985, however, the industrial proportion of overall AMA demand has remained fairly stable over the period. Industrial users with groundwater rights or permits accounted for approximately 4 percent of the AMA's total water use in 1995. Although only a small proportion of the total AMA water use, 86 percent of the water used in this sector is from groundwater supplies. The remaining 14 percent comes from deliveries by irrigation districts and effluent supplied by municipal providers. Industrial use in the Phoenix AMA is dominated by turf-related facilities which include schools, parks, cemeteries, golf courses, and other facilities with a water-intensive landscaped area of 10 or more acres. These facilities are characterized by turf-grass irrigation, and thus have water demand characteristics highly dependent on weather conditions.

Table 3-15 identifies the number of industrial facilities, associated groundwater rights and permits, and the volume of water used in 1995 for facilities subject to each of the industrial conservation requirements in the Second Management Plan (except for Large-Scale Cooling Facilities, which have not been identified). Turf-related facilities that are classified by the Department as "individual users" are not included in this table. These individual users are identical in character to the industrial turf-related facility water users, however, they receive their water from a municipal provider instead of from a Type 1 or Type 2 non-irrigation right or a general industrial use permit. It is important to note that water use by individual users is not discussed in the industrial sector, because the water is supplied by a municipal provider and is included in the water use for that sector.

Since industrial users are groundwater right or withdrawal permit holders, it is not surprising that the majority of water use by industrial users, or 86 percent, is groundwater. Only some turf-related facilities that are industrial users use sources other than groundwater; these sources are mostly surface water delivered by irrigation districts to the facilities. Characteristics within each industrial category are discussed briefly below and water use by each category is illustrated in Table 3-16.

TABLE 3-15
1995 INDUSTRIAL GROUNDWATER RIGHTS AND WITHDRAWAL SUMMARY
PHOENIX ACTIVE MANAGEMENT AREA

User Category	Right or Permit	Number of Facilities	Right or Permit Volume (acre-feet)	Groundwater Use (acre-feet)	Total Water Use (acre-feet)
Large-Scale Power Plants	Type 1 & Type 2-electrical generation	4	12,062	3,832	3,832
Dairies	Type 1 & Type 2; industrial use permits	86	15,676	8,423	8,423
Feedlots	Type 1 & Type 2; industrial use permits	10	2,214	809	809
Sand and Gravel Facilities	Type 1, Type 2, Type 2-mineral extraction; mineral extraction permits	22	26,196	8,278	8,278
Turf-Related Facilities	Type 1 & Type 2; industrial use permits	110	69,755	37,424	49,227
Other Industrial Users [1]	Type 1 & Type 2; industrial use permit	304	70,994	12,519	12,519
Total			**196,897**	**71,285**	**83,088**

[1] Includes water used by Large Cooling Users, New Large Landscape Users, New Large Industrial Users, and Other Industrial Users

TABLE 3-16
1985, 1990, AND 1995
INDUSTRIAL WATER DEMAND BY CATEGORY (ACRE-FEET)
PHOENIX ACTIVE MANAGEMENT AREA

	1985	1990	1995
Turf-Related Facilities	48,327	43,930	49,227
Sand and Gravel Operations	6,895	7,681	8,278
Dairies	5,457	6,708	8,423
Large-Scale Power Plants	2,092	3,128	3,832
Feedlots	951	903	809
Other	9,763	11,417	12,519
Total	**73,485**	**73,767**	**83,088**

Large-Scale Power Plants

Between 1984 and 1986, electric power plants withdrew an average of approximately 2,100 acre-feet of groundwater per year. Although water users in this category hold rights to withdraw over 12,000 acre-feet of groundwater per year, in 1995 electrical power plants only used approximately 3,832 acre-feet of groundwater.

Dairy Operations

Eighty-six dairies have been identified in the Phoenix AMA. Water use in this category has been steadily increasing, with groundwater as the primary source. In 1985, dairy operations used approximately 5,457 acre-feet of water, and by 1995 these users pumped over 8,400 acre-feet.

Cattle Feedlot Operations

In 1995, cattle feedlots used approximately 809 acre-feet of water, a decrease from 951 acre-feet in 1985. Additional reductions in use are expected throughout the third management period as urbanization occurs in rural areas of the AMA where feedlots are located.

Sand and Gravel Facilities

Sand and gravel facilities mine unconsolidated stream deposits to produce construction materials and are primarily dependent on groundwater supplies to meet their water demand. Annual water use in this sector has fluctuated from approximately 6,900 acre-feet to approximately 13,600 acre-feet, due to the association with construction.

Turf-Related Facilities

This sector of industrial users include golf courses, schools, parks, cemeteries, and common areas of sub-divisions. Landscape watering by turf-related facilities dominates industrial water use in the Phoenix AMA. Turf-related facility water use has increased from approximately 87,700 acre-feet in 1987 to 97,151 acre-feet in 1995. Of this amount, 51 percent, or 49,227 acre-feet, was used by industrial groundwater right or permit holders while 49 percent, or 47,924 acre-feet, was used by facilities that are individual users receiving water from a municipal provider. During this period, some turf-related facilities have begun to take water from a municipal provider rather than exercising their industrial rights. Additionally, most new turf-related facilities are being developed on municipal supplies. Municipally served turf-related facilities are supplied greater percentages of surface water, including CAP and effluent.

Large-Scale Cooling Facilities

Water use in this category has not been historically identified due to the lack of record-keeping and possibly due to the fact that most of these uses are supplied by municipal providers instead of groundwater withdrawal authorities.

New Large Landscape Users

No new large landscape users were identified during the second management period. Most of this use may be provided by municipal providers. However, potential exists for the use of groundwater under withdrawal authorities for new large landscape users.

New Large Industrial Users

Water use in this category has increased since it was established in 1992 due to the addition of six new large industrial users. In 1995 water use in this category totaled 3,100 acre-feet. Although the trend for new large industrial users to be served water by a municipal provider is most likely going to continue, it is expected that additional large industrial users will use non-irrigation rights in the third management period.

Other Industrial Users

The second largest use category is "other" industrial users. This category of water users is comprised of miscellaneous industrial users that did not have specific conservation requirements in the Second Management Plan, although the unreported cooling tower water use is most likely included in this volume. In 1995, other industrial users used over 12,000 acre-feet; an increase from the 9,763 acre-feet used in 1985.

3.4.2 Industrial Supplies

Industrial water use in the Phoenix AMA has increased approximately 13 percent since 1985. The proportion of groundwater and surface water use has remained fairly constant throughout this period. Industrial users currently use considerably less groundwater than they are entitled to use pursuant to their grandfathered groundwater right or permit allotments. When aggregated, industrial users were entitled to an allotment of 196,897 acre-feet per year in 1995, not including dewatering, hydrologic testing, and poor quality permits. Actual groundwater use by industrial users totaled only 71,285 acre-feet in 1995, or 36 percent of the aggregated allotment. The difference between the allotment volume and actual use is partially explained by the process used to establish non-irrigation grandfathered groundwater rights. The allotment for Type 2 non-irrigation rights was set at the highest annual pumping from 1975 through 1979. Industrial production levels and associated water use can fluctuate widely in response to varying economic conditions and in some cases were high during the historic period in comparison to current use conditions.

Although the definition of industrial users appears to limit this sector to groundwater use, renewable supplies (especially effluent), can be utilized. Turf-related facilities account for the largest proportion of the demand in this sector – approximately 59 percent of the total industrial use. The water quality requirements for turf irrigation do not require a high quality, potable, water supply. Thus, the utilization of effluent could reduce the impact of groundwater use on these facilities. However, the availability of the infrastructure necessary to deliver effluent to these users, in addition to concerns about public health, increased cost, and increased maintenance, may be limiting the actual use of this resource. With 60 percent of the effluent that is produced in the Phoenix AMA not being utilized, it appears that significant increases in effluent use could occur if the financial resources (cost of the supply and cost of the necessary infrastructure) were made available to transport the water to the actual users. It is expected that new turf-related facilities will be using increasing amounts of the available effluent produced in the future. Table 3-17 shows industrial water use by source for 1985, 1990, and 1995.

3.4.3 Summary

Because the definition of an industrial user is limited to non-irrigation withdrawal authorities, this sector is primarily dependent upon groundwater withdrawals to meet demand. This sector is expected to increase to meet the needs associated with additional population, although water demand for most new turf-related facilities will be met by municipal providers. As water use in the industrial sector increases, groundwater use will also increase.

TABLE 3-17
1985, 1990, AND 1995
INDUSTRIAL WATER USE BY SOURCE (ACRE-FEET)
PHOENIX ACTIVE MANAGEMENT AREA

	Groundwater	Surface Water	CAP Water	Effluent	Total Industrial Use
1985	62,558	10,356	0	571	73,485
1990	67,649	1,709	395	4,014	73,767
1995	71,285	7,250	1,530	3,023	83,088

3.5 PHOENIX ACTIVE MANAGEMENT AREA WATER BALANCE

Table 3-18 contains information on water supply and demand within each demand sector for the years 1990 through 1995. This water balance is reflective of actual conditions during this time period. Sector demands were obtained from a combination of annual groundwater withdrawal and use reports and annual water storage and recovery reports. Natural system demand components were derived from information provided in Chapter 2 along with the Department's Hydrology Division. Supply components were also retrieved from these same information sources.

The table displays a variable trend in water supply utilization when compared against the cumulative water demands of the Phoenix AMA. Each water demand sector demonstrates a contribution to the overdraft in the Phoenix AMA. Although the overdraft varies from year to year, a consistent level of demand exceeds renewable supplies throughout the time period displayed. This table represents only a brief period of time, however, serious questions are being raised about the likelihood of achieving safe-yield. Although a large portion of the future municipal demand will be required to develop with a reliance on renewable supplies rather than groundwater, agricultural, industrial, and some municipal users do not have any obligation to eliminate groundwater mining through the management periods. The volume of this residual groundwater mining is substantial – approximately 365,000 acre-feet in 1995. This illustration is essential for supporting the development of conservation requirements contained in this management plan and the proposals to develop additional mechanisms necessary to attain the management goal of the Phoenix AMA, described in Chapter 12.

3.6 CONCLUSIONS

As described in the previous sections, each water demand sector has unique characteristics which have effected past and current water use patterns. The municipal sector has exhibited the greatest amount of growth since 1980 while agricultural use has declined somewhat. Industrial use has displayed moderate growth.

Table 3-18 illustrates the current contribution to overdraft by each sector. The water demand characteristics described above, including sources of supply utilized, when projected to continue through-out the third management period and beyond (see Chapter 11), illustrate that additional water conservation and augmentation programs are necessary in order to achieve the AMA goal by 2025.

TABLE 3-18
1990-1995 HISTORICAL WATER BUDGET
PHOENIX ACTIVE MANAGEMENT AREA

Sector	1990	1991	1992	1993	1994	1995
Agricultural						
Demand						
Indian	236,216	234,803	223,822	221,651	223,467	224,780
Non-Indian	1,023,970	974,652	909,098	962,066	1,067,352	1,109,105
Supply						
Renewable	444,139	612,671	619,360	619,907	663,189	760,702
Groundwater	816,047	596,784	513,560	563,810	627,630	573,183
Incidental Recharge	337,304	323,953	303,562	316,830	344,984	356,322
Overdraft	**474,743**	**272,831**	**209,998**	**246,980**	**282,646**	**216,861**
Municipal						
Demand						
Indian	4,384	4,727	5,125	5,476	7,131	6,975
Non-Indian	778,090	750,956	761,699	786,000	823,473	862,987
Supply						
Renewable	490,427	523,459	568,953	564,636	559,254	616,377
Groundwater	292,047	232,224	197,871	226,840	271,351	253,585
Incidental Recharge	57,895	56,932	57,465	58,521	60,142	61,887
Overdraft	**234,152**	**175,292**	**140,406**	**168,319**	**211,209**	**191,698**
Industrial						
Demand	73,767	73,007	70,167	76,173	77,911	83,088
Supply						
Renewable	6,118	9,212	11,302	10,150	9,671	11,803
Groundwater	67,649	63,796	58,865	66,023	68,239	71,285
Incidental Recharge	6,683	6,614	6,356	6,901	7,058	7,527
Overdraft	**60,966**	**57,182**	**52,509**	**59,122**	**61,181**	**63,758**
Riparian						
Demand	48,000	48,000	48,000	48,000	48,000	48,000
Supply						
Renewable	0	0	0	0	0	0
Groundwater	48,000	48,000	48,000	48,000	48,000	48,000
Incidental Recharge	0	0	0	0	0	0
Overdraft	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**
Other						
Demand						
Total Natural Outflows	*28,600*	*28,600*	*28,600*	*28,600*	*28,600*	*28,600*
Supply						
Total Natural Inflows	*(137,700)*	*(137,700)*	*(137,700)*	*(137,700)*	*(137,700)*	*(137,700)*
Unused 91st Ave WWTP	*(46,000)*	*(46,000)*	*(46,000)*	*(46,000)*	*(46,000)*	*(46,000)*
Cut-to-the-Aquifer	*(28)*	*(2)*	*(7,861)*	*(12,022)*	*(2,106)*	*(5,197)*
Overdraft	*(155,128)*	*(155,102)*	*(162,961)*	*(167,122)*	*(157,206)*	*(160,297)*
Total Net Overdraft	**666,734**	**398,203**	**287,952**	**355,300**	**445,830**	**360,019**
Cumulative Overdraft	**666,734**	**1,064,937**	**1,352,889**	**1,708,189**	**2,154,019**	**2,514,039**